NAC Institutional Committee Briefing on Facilities Maintenance and Energy

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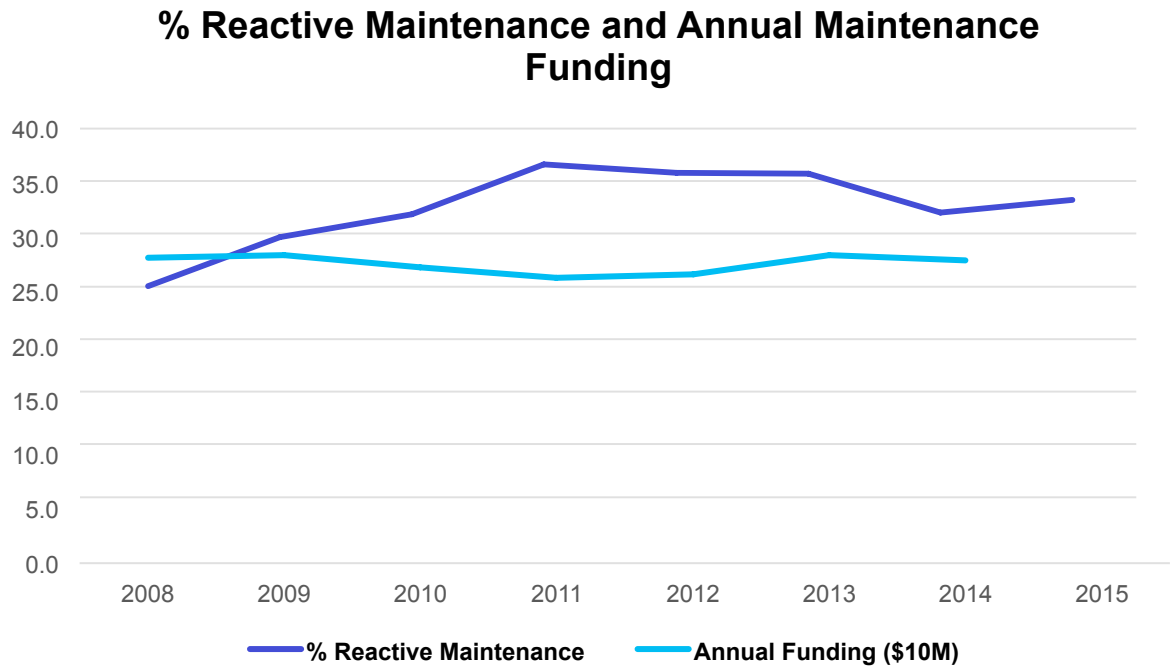
NASA's Facilities Maintenance Program

Current Issues in Facilities Maintenance Program

- Maintenance resources, budgets and personnel, continue to decline as part of overall budgetary pressure.
- Scheduled (preventative and proactive maintenance) is being reduced.
- Unscheduled (reactive) maintenance is increasing.
- Facility sustainment relies too heavily on large capital investments (Construction of Facilities projects - CoF).
- Centers lack resources to invest in technologies or strategies to improve maintenance performance and reduce costs (metering, in field computerized maintenance management systems , remote monitoring, detailed facilities assessments)..

Unscheduled Maintenance as % of Total Maintenance

Fiscal Year	% Reactive Maintenance
2008	25.1
2009	29.8
2010	32.0
2011	36.7
2012	35.9
2013	35.8
2014	32.1
2015	33.3



NASA's percent Unscheduled Maintenance to total maintenance has been at or above 30% since 2009.

Measuring Unscheduled Maintenance

For 2016, NASA established the performance goal of reducing unscheduled maintenance by 2% per year with a long term goal of reducing unscheduled maintenance to below 25%. In 2015, NASA tracked unscheduled maintenance against a 2014 baseline.

Performance Against Unscheduled Maintenance Annual Performance Goal

Performance vs. Center's 2014 Baseline	Number of Centers
Unscheduled Maintenance Reduced by more than 2%	4
Unscheduled Maintenance Reduced by less than 2%	2
Unscheduled Maintenance Increased	4

Good News/ Bad News:

Good News: 6 of NASA's 10 Centers were able to reduce unscheduled maintenance from 2014.
Bad News: Unscheduled maintenance went up overall. Unscheduled maintenance at Centers varies from 21% to 54%. The unscheduled maintenance at 3 Centers exceeds 40%; the equivalent of spending more than 2 days/ work week repairing broken systems.

Facilities Condition

Many of NASA's facilities and systems have become unreliable and are impacting NASA's missions.

- Cooling water system failure caused a 2 month shutdown of a tunnel, loosing an estimated $2M in test availability. (2015)
- Building air compressor failure, halted testing. (2013)
- 16 inch water main broke. Shut the entire Center down for 2 days. Approximately 10,000 people could not work. (2013)
- 22 KV transformer failed which supplied power to the National Transonic Facility (NTF) Cryogenic Pumps. NTF was down for a week. (2013)
- Chiller failure resulting in a loss of cooling to the area that supports the LADEE Mission. (2013)
- Combustion air pipe leak which delayed testing. (2013)
- Tunnel down for a month due to the model injection system failure. (2013)

Maintenance Funding

NASA studies determined that maintenance funding is insufficient to sustain the facilities inventory

- Baseline Service Level Study (2010) **1.6%** of CRV to maintain current condition.
- Series of O & M Cost Studies recommended maintenance levels for the following 6 facility types:

Building Type	*Recommended Maintenance Funding (%CRV)*
Administrative Buildings	2.2
Propulsion Test Facilities	.70
Communications Buildings/Data Centers	5.3
Space Science R & D Facilities	1.9
Warehouses	2.4
Wind tunnels	.70

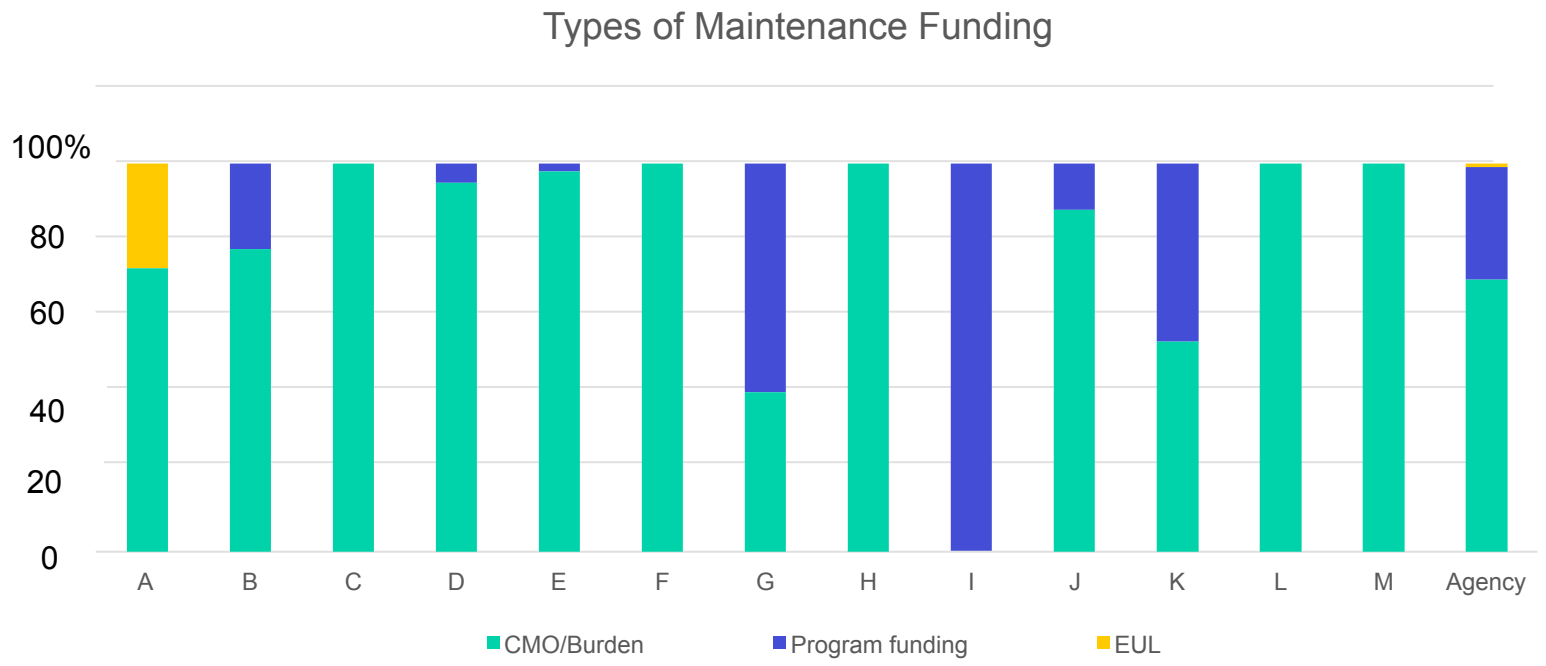
Funding levels from FY11-FY14 have been between **0.84%** and **0.89%** of CRV.

Funding Sources for Facilities Maintenance

Maintenance funding comes from several sources other than Center Management & Operations (CMO). This makes it difficult to track maintenance funding and manage maintenance resources.

Funding sources include:

- CMO
- Program
- Tenants
- Reimbursable agreements
- Enhanced Use Lease



Capital Repairs to NASA's Infrastructure

80% of NASA's Institutional Construction of Facilities (CoF) Program are repair, upgrades or replacement projects thus being the primary focus for NASA's construction funds.

FY 16 CoF Budget Request:

- $165.3 million in repairs in institutional CoF.
- $15.1 million in repairs in program CoF.
- $15 million demolition funds to reduce deferred maintenance and annual O&M costs.
- $94.7 million construction of the Measurement Sciences Lab will replace several substandard lab facilities at LaRC to reduce deferred maintenance and repair costs.

Prioritizing Maintenance

Although Centers use different approaches to prioritizing maintenance, Centers consider mission risk when prioritizing maintenance.

- Maintenance of life safety systems
- Maintenance of safety critical systems such as pressure/ vacuum systems and lifting devices
- Identifying mission critical systems
- Utilizing mission dependency index
- Utilizing predictive testing and inspection on critical systems
- Failure modes and effects analysis on critical systems
- Safety of maintenance workers

Investing in Technology

- In FY 14 the Centers received funding to invest in remote and continuous monitoring of critical equipment.
- $200k - $500k/ Center
- Example investments:
  - Remote monitoring of two critical pump lift stations
  - Upgrading the Center-wide Building Automation System (BAS)
  - Remote monitoring of transformer oil and UPS Batteries
  - Remote monitoring of cooling tower fans
- These investments should continue but budget pressure makes it difficult for Centers to continue to invest in technologies that reduce maintenance requirements.

The Way Forward

- Continue a program of investing in technologies that will support improved maintenance management under constrained resources.
- Assess best practices within and outside of NASA to identify ways to improve the efficiency of maintenance.
- Continue monitoring unscheduled maintenance as a way of tracking system reliability.
- Improve tracking of maintenance funding to ensure that all sources are identified and can be incorporated into maintenance planning.
- Develop a maintenance strategy that will reduce maintenance requirements through technology and inventory reduction, utilize prioritizing tools to establish the best balance for available funds, and bring more resources to bare when needed.

NASA's Facilities Energy Program

Requirements Driving Energy Management Over the Next Decade

Several laws, regulations and executive orders have driven energy management policy in the past. In March 2015, the President issued Executive Order 13693 "Planning for Federal Sustainability in the Next Decade." This EO sets goals in new areas and increases performance expectations in many existing areas.

- Sustainable acquisition
- Building energy, including clean/renewable energy
- Sustainable buildings
- Water consumption
- Waste reduction
- Greenhouse gas emission reductions

These requirements will have a significant impact on both the construction and management of NASA facilities.

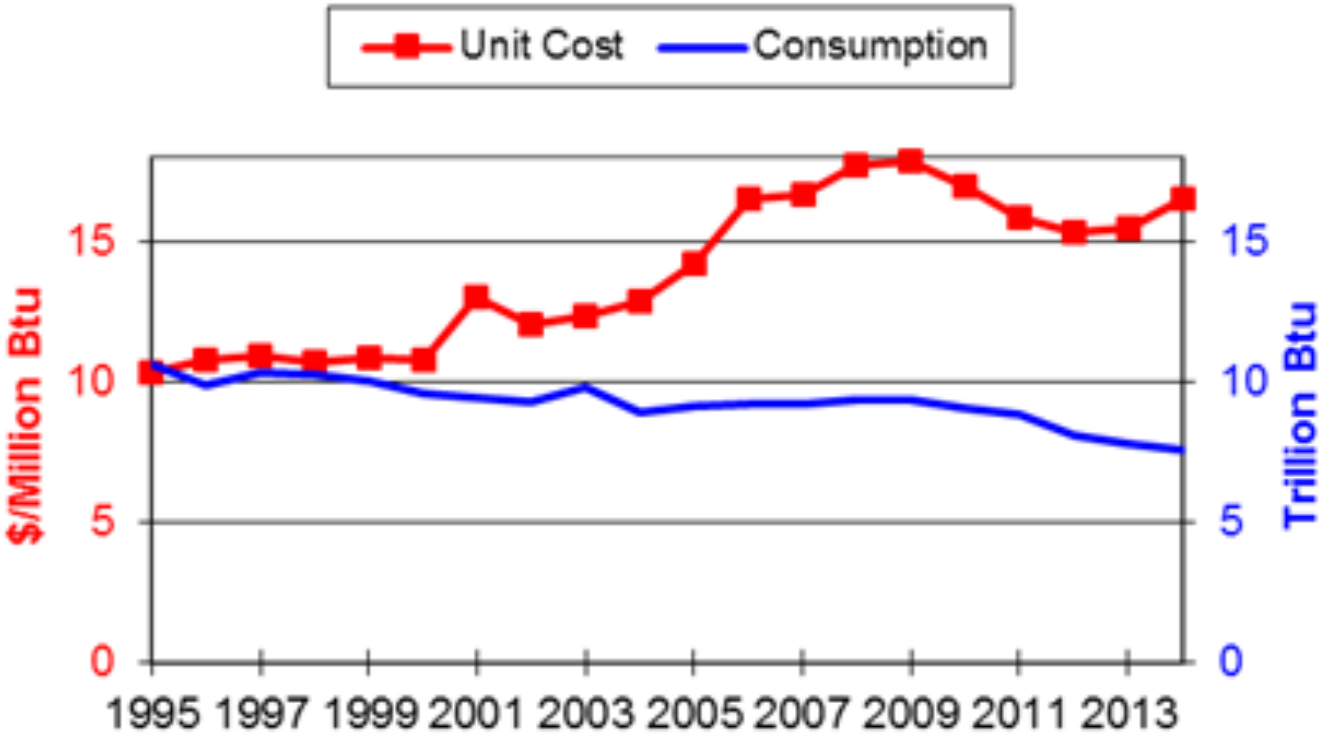
Performance Metrics Under EO 13693

EO 13693 significantly increases requirements and necessary investment

Topic	Previous Requirement	FY 2014 Actual	EO 13693 Requirement
Energy Intensity	30% below FY 2003 baseline by end of FY 2015	25.9% below FY 2003 baseline	25% below new FY 2015 baseline by end of FY 2025
Renewable Electric Energy	7.5% of total electricity FY 2013 & beyond	8.9% of total electricity	30% of total electricity FY 2025 & beyond
High Performance and Sustainable Buildings	15% of bldgs comply with Guiding Principles by F2015	10.7% of bldg count and 15.3% of sf	15% of bldgs comply with revised Guiding Principles by FY2025
Net–Zero Energy Buildings	New buildings entering planning process beginning FY 2020 designed to achieve energy net-zero by FY 2030	N/A	New buildings--previous requirement plus where feasible water or waste net-zero; existing buildings--NASA identified 1% intended to achieve energy, waste, or water net-zero by FY 2025
Clean Energy	no requirement		25% of total energy FY 2025 & beyond

Utilities Consumption and Cost

- Centers spent $125.6M on facilities energy in FY 2014
  - Mostly Center Management & Operations funding; some program
- NASA has made progress in reducing consumption but utilities unit cost increases outpace those reductions



Funding Energy Initiatives

Energy project funding or efficiency improvements come from several sources:

- CMO – Center Energy Programs
- Energy Performance Contracts
- CoF Projects
  - Energy Savings Investments (targeted energy projects including metering, photovoltaics, HVAC, etc.)
  - Construction of Sustainable and Net Zero Buildings
- Enhanced Use Lease proceeds (35%) and in-kind consideration

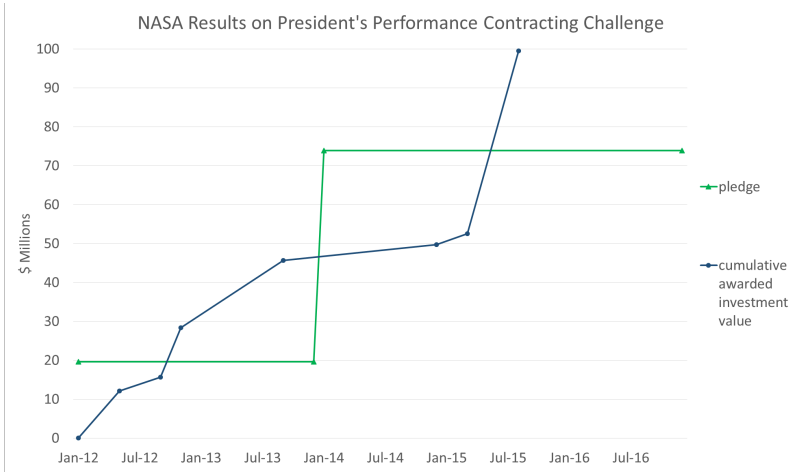
Center Management and Operations

- **Center Energy Programs**
  - Funded from sources within CMO
  - Projects identified by Center energy managers through studies and assessments
  - One Center has been successful in setting aside cost avoidances from energy projects to use for re-investment in additional energy projects
  - Many Centers actively use energy performance contracts as a way to fund larger projects and pay back the investment over time through utility cost avoidances

Energy Performance Contracts

- **Energy Performance Contracts**, some spanning 20+ years
  - Enables energy service companies and utility companies to finance energy projects that NASA repays over time from avoided utility costs
  - As part of the President's Performance Contracting Challenge, NASA committed to award $73.9M in contracts by 2016

Example project: $47.0M Combined Heat and Power at JSC in FY15 brought NASA's total challenge investment to date to $99.5M



Project	Award Date	Award ($M)
WFF heat pumps	5/30/12	12.2
KSC HVAC	9/27/12	2.7
KSC lighting	9/25/12	0.8
JPL NMO HVAC/light	11/7/12	12.7
JPL chilled + hot water	9/13/13	16.6
KSC lighting	9/30/13	0.7
JPL chilled water	12/18/14	4.0
GSFC plant controls	3/13/15	2.8
JSC heat & power	8/5/15	47.0

CoF Energy Savings Investments

- **CoF Energy Savings Investments, $12.2M/yr**
  - Funds projects focused on reducing utilities cost and consumption and increasing renewable energy
  - Centers propose projects
  - NASA Energy Efficiency Panel prioritizes projects
    - Payback period
    - Dollars invested per million Btus saved
    - Renewable energy investments

Example project:

$8.0M Upgrade Utility Metering, Primarily Gas and Steam deploys building-level metering for better energy management

CoF Sustainable and Net Zero Buildings

- **Construction of Facilities** (CoF) Recapitalization, $115M/yr
  - New construction and major renovation projects incorporate sustainable building principles including energy efficiency
  - Older, inefficient facilities are demolished as part of replacement facility projects

Example project: $12.7M AFRC Facilities Support Center earned LEED New Construction Platinum including 30 of 35 credits in Energy and Atmosphere. Includes 36 Kilowatt solar photovoltaic system.

Enhanced Use Lease

- **35% of Enhanced Use Lease** net revenue, $1.5M/yr
  - Helps NASA implement small-scale energy & sustainability upgrades
- Authority permits in-kind consideration for renewable energy projects

Example project from EUL proceeds:

$276K LEED Existing Building Certification for GSFC-WFF Building E-109 earned certification through retrocommissioning and implementing facility improvements

Example in-kind project:

KSC hosted a ten MegaWatt solar photovoltaic (PV) system for the local electric utility company and received a 1 MegaWatt PV system as in-kind consideration

Energy Management Strategy

- Develop Energy Investment Plans for Centers and Agency
  - Including identifying resources (Funds and people) needed to meet EO goals
- Evaluate large-scale opportunities at Centers to identify best energy investments across NASA
- Continue the CoF Energy Savings Investments program to fund large-scale energy conservation and renewable energy projects
- Encourage partnering with energy service companies and utilities to utilize energy performance contract authorities
- Continue to build sustainable buildings that help reduce energy and water consumption and expenditures
- Deploy tactics to enable Net Zero Energy Building construction
- Audit and monitor Center energy consumption and encourage Agency-wide reductions
- Establish a renewable energy strategy through a combination of on-site projects and purchases of utilities and certificates